HOW TO FILL OUT THE WASTE UTILIZATION JOBSHEET

When viewing the Excel version of the jobsheet:
1 – the blocks highlighted in green are **required** for automated value calculation.
2 – the blocks highlighted in yellow are used for making manual calculations.
3 – the blocks highlighted in blue are the formula outputs, and require no user inputs.

Enter the landuser's name, county, date and who assisted with the planning.

Step 1. Resource Inventory

Inventory:

- number of animals *(Example 1,000)*
- average weight of animals *(Example 1,200 pounds)*
- number of days per year that waste is produced/stored *(Example 365 days)*
- weight of waste produced (lb/day/1000# body weight from Ag Waste Management Field Handbook Chapter 4 values) *(Example 60 pounds)*
- as excreted moisture content (% from Ag Waste Management Field Handbook Chapter 4 values) *(Example 88%)*
- moisture content (% from manure laboratory analysis) *(Example 30%)*

Steps 2 – 3 are used to approximate the total manure that will be produced when using as-excreted values

Step 2. Manure Production As-excreted

Calculate the manure production on an as-excreted basis (tons). The calculation is:

No. animals x avg. wt./1000 x days stored x waste produced/2,000

For this example:

(1000 animals x 1,200/1,000 x 365 days x 60 lb) ÷2,000 = 13,140 tons as excreted

Step 3. Manure Production Adjusted for Moisture Content

Step 3a.

Adjust the manure production for moisture content. The calculation is:

% dry matter = 100 - % moisture (as excreted)

For this example:

% dry matter = 100 – 88% moisture = 12% dry matter

Step 3b.

Calculate Dry Matter Production. The calculation is:

Dry Matter Production = Total Manure Produced x % Dry Matter from Step 3a

For this example:

Dry Matter Production = 13,140 tons x 12% Dry Matter = 1,577 Tons Dry Matter

Step 3c.

Calculate Dry Matter % Moisture Content (as is). The calculation is:

% Dry Matter = 100 - % moisture as analyzed

For this example:

% Dry Matter = 100 – 30% = 70 percent Dry Matter as analyzed

Step 3d.

Calculate Production at Given Moisture Content. The calculation is:

Production at Given Moisture Content =
Dry Matter Production + [Dry Matter Prod. X (moist. content/dry matter % as is)]

For this example:

Production at Given Moisture Content =
1,577 tons + [1,577 x (30/70)] = 2,253 tons at 30% moisture content

Step 4. Manure Analysis

At a minimum, a manure analysis should contain the following information:

- moisture content (%)
- nitrate nitrogen (% or lb/ton)
- urea nitrogen (% or lb/ton)
- organic nitrogen (% or lb/ton)
- total nitrogen (% or lb/ton)
- phosphorous (% or lb/ton)
- potassium (% or lb/ton)

If a manure analysis is unavailable, refer to the tables in Chapter 4 of the Ag Waste Management Field Handbook.

Phosphorous and potassium amounts in manure analysis are often expressed as elemental P and K. To convert to the oxidized forms, multiply P by 2.29 and K by 1.21 to get P_2O_5 and K_2O respectively.

For this example, we have:
1.49 lb/ton nitrate nitrogen
1.3 lb/ton urea nitrogen
22.89 lb/ton organic nitrogen
16.28 lb/ton P_2O_5
40.55 lb/ton K_2O
moisture content of 30%.

Step 5a. Total Nutrients

These values are not used in any calculation, but are included as a planning tool so producers can see the nutrient value of their ag wastes.

The calculation is:

Total Nutrients = pounds of nutrient/ton x tons manure produced

For this example:
Total Nitrate N = 1.49 lb $NO_3 - N$*/ton x 2,232 tons = 3,356 lb* $NO_3 - N$
Total Urea N = 1.3 lb urea N/ton x 2,253 tons = 2,928 lb Urea - N
Organic N = 22.89 lb N/ton x 2,253 tons = 51,561 lb organic N
Total P_2O_5 *= 16.28 lb* P_2O_5*/ton x 2,253 tons = 36,672 lb total* P_2O_5
Total K_2O *= 40.55 lb* K_2O*/ton x 2,252 tons = 91,342 lb total* K_2O

Step 5b. Economic Value of Nutrients

These values will assess the economic value of the nutrients from step 5a. To determine the value, the cost per pound of nutrient if commercially applied must be known. For this example, N = $.18/lb, P_2O_5 = $.10/lb and K_2O = $.12/lb. 45% of the organic N and 100% of both the nitrate and urea nitrogen are used in this calculation.

For this example:
[(51,561)(.45) + (3,356) + (2,928)](.18) = $5,307 for nitrogen value
(36,672)(.10) = $3,667 for phosphorous value
(91,342)(.12) = $10,961 for potassium value

Step 6. Plant Available Nutrients

Nutrients must be plant-available to be considered in the Waste Utilization Plan. Some forms of nutrients are already plant-available, such as nitrate-nitrogen. The process of mineralization converts nutrients that are not plant-available from the organic (not plant-available) to mineral forms (plant-available).

From the manure analysis, compute the lbs/ton of nitrate-nitrogen. Then figure the amount of mineralized nitrogen, using the average mineralization rate of 45%. Perform similar mineralization calculations for phosphorous (mineralization rate of 90%) and for potassium (mineralization rate of 95%). Refer to Table 11-9 in the AWMFH for mineralization value definitions.

For this example:
1.49 lb/ton nitrate-nitrogen x 100% available = 1.5 lb/ton $NO_3 - N$
1.3 lb/ton urea – nitrogen x 100% available = 1.3 lb/ton urea - N
22.89 lb/ton organic - nitrogen x 45% mineralization rate = 10.3 lb/ton nitrogen
16.28 lb/ton P_2O_5 *x 90% mineralization rate = 14.7 lb/ton phosphorous*
40.55 lb/ton potassium x 95% mineralization rate = 38.5 lb/ton potassium K_2O

Step 7. Application Losses

Portions of the urea and mineralized organic nitrogen components will volatilize when land-applied. The rate of volatilization will vary depending upon site parameters such as soil conditions and time to incorporation. To determine the percentage of urea and mineralized organic nitrogen retained after application, refer to Table 11-6 in the AWMFH.

For this example:
Soil is cool and wet and time to incorporation was 8 days
The percentage nitrogen remaining is therefore 90%
1.3 lbs/ton (from Step 6) x 90% = 1.2 lbs/ton urea nitrogen
10.3 lbs/ton (from Step 6) x 90% = 9.3 lbs/ton mineralized organic nitrogen

Step 8. Pounds of Available Nutrients

Step 8 is simply a table to reflect lbs/ton of available N, P_2O_5, and K_2O, after all mineralization and application adjustments have been made, and the nitrate and urea fractions have been added to the mineralized organic nitrogen fraction.

For this example:
N = 12 lbs/ton (9.27 lbs/ton + 1.49 lbs/ton $NO_3 - N$ *+ 1.17 lbs/ton urea – N))*
P_2O_5 *= 15 lbs/ton*
K_2O *= 39 lbs/ton*

Step 9. Nutrients Required by Crop

To accurately determine the nutrients required by a crop, there are two critical components to quantify: 1 – realistic crop yield goals and 2 – current soil test levels.

Realistic Yield Goals

Enter the expected yield for the current crop. There are spaces available for up to 3 separate crops. The expected yield is the basis for determining the nutrient requirement for the current crop. An unrealistic estimate of expected yield can result in either too many nutrients being applied creating potential for environmental contamination and inefficient use of the resource, or too few nutrients being applied, causing crop stress and limiting potential yield.

The expected yield should be based on realistic soil, climate and management parameters including crop variety, and may be determined from producer records or county yield averages, soil productivity tables, or local research. Because climate can have a dramatic effect on yields, expected yield should be based on at least 5 years' data. Extreme climate years should not be included in the analysis, as they may bias the results. Discard the high and low values, average the 3 remaining values, and add 5%.

Expected yields may be calculated in a variety of ways. In our example, the corn yields obtained on the field over the past five crop years were: 157, 146, 140, 80, and 142 bushels per acre. To estimate expected yield we eliminate the extreme low and high yields and take the average of the three remaining yields. Adding 5% to the over-all average will compensate for prospective favorable weather conditions and potential varietal improvements. The estimated yield is than, (146 + 142 + 140)/3 = 143 bushels, plus 5% = 150 bushels per acre.

Current Soil Test Levels

The nutrient status of the soil is a key component of a nutrient management plan. This information is used to make recommendations for nutrient application. **As per NRCS Nutrient Management Policy, a soil test no more than 5 years old is required**. In this section, enter the soil test values (ppm) for N, P (P_2O_5), K (K_2O), and other soil constituents as given in the report from the soil-testing laboratory.

For this example:
soil test values are:
10 ppm NO_3-N
9 ppm P_2O_5
30 ppm K_2O
pH 7.5
SOM 1.2%
no test taken for EC.
The soil tests were taken from the 0-3 foot soil depth in a coarse-textured soil.

Step 10. Recommended Nutrients/Amendments to Meet Expected Yield.

Using the soil test results and considering the expected yield, record the estimated amounts of nutrients and other soil amendments needed to produce the expected yield. The land grant university or other approved soil test laboratories will base nutrient requirements for the crop on the soil test results, crop yields from field research, and local climatic conditions. Consult Agronomy Tech Note #10 (Wyoming Guide to Fertilizer Recommendations). Nutrient recommendations come from extensive research results from similar soils and climatic conditions to develop recommended nutrient rates.

For this example:
Recommended nutrients based on realistic yield goals and current soil test information:
210 lb. N
45 lb P_2O_5
185 lb. K_2O

Nutrient Sources - Credits

A number of nutrient sources for crop production are available before and after the crop is planted. One source is the inherent nutrients in the soil determined by soil test levels of nitrogen, phosphorus, and potassium. Others become available to the crop through a process of recycling through animals, plants, air, water, and organic matter. Nitrogen from legumes and organic waste mineralization are examples, as is nitrogen from irrigation water.

Nitrogen Credits

Step 11. Crop Nitrogen Requirement after Nitrogen Credit from Irrigation Water. Irrigation water, especially from shallow aquifers, can contain some nitrogen in the form of nitrate nitrogen. This nitrogen is available for crop use. To calculate the amount of nitrogen applied with irrigation water, determine the concentration of nitrate nitrogen in the water (in ppm or mg/L). This will require a water analysis. The amount of nitrogen added in irrigation water will equal the nitrate nitrogen concentration (in ppm or mg/L), multiplied by the net irrigation water applied (in acre-feet), times 2.7. The factor 2.7 converts ppm or mg/L and acre-feet into pounds per acre.

For this example:
18 acre-inches of irrigation water are applied having a nitrate nitrogen concentration of 4.5 ppm.
N (lb/acre) = Concentration of NO_3-N (ppm or mg/L) X volume of irrigation (acre-feet) X 2.7 → 18/12 X 4.5 X 2.7 = 18 pounds N per acre.

Therefore, the adjusted crop nitrogen requirement is 192 lb/ac (210 – 18 = 192).

Step 12. Crop Nitrogen Requirement after Nitrogen Credit from Previous Legume Crop. Rhizobium bacteria, via symbiotic relationships with legume plants, fix atmospheric nitrogen. Amounts of nitrogen added by legume production vary by plant species and growing conditions. Refer to local university extension information for the most appropriate legume nitrogen credits.

If no local information is available, use 40 pounds per acre for elevations below 6,000 feet and 30 pounds per acre for elevations above 6,000 feet**. Only apply**

this credit, if a legume has been part of the crop rotation since the last soil test.

For this example:
assume 40 pounds of nitrogen credit from a previous legume crop.

Therefore, the adjusted crop nitrogen requirement is 152 lb/ac (192 – 40 = 152).

Step 13. Nitrogen-based Manure Application Rate

Once we have figured the values for both the supply and the demand side of the equation, we can calculate actual manure application rates. Plants utilize N, P, and K in an approximate ratio of 5:1:5, and manure supplies N, P, and K in an approximate ratio of 3:1:2. Therefore, it is necessary to calculate manure application rates for each of the primary nutrients.

For this example for nitrogen:
Our 150 bu/ac corn crop requires 210 lb/ac of nitrogen. Once we subtract the nitrogen supplied by irrigation water and that supplied via symbiotic fixation, we know we need to supply 152 lb/ac of nitrogen via manure (210 – 40 – 18 = 152).

We also know that our manure can supply 11.93 lb/ton of nitrogen. Therefore, we can calculate a nitrogen-based manure application rate.

For this example:
The 150 bu/ac corn crop requires 152 lb of N per acre be supplied by manure.
The manure can supply 11.93 lb of N per ton
Therefore:
152 lb/ac x 1 ton/11.93 lb = 13 tons/acre

Step 14. Phosphorous-based Manure Application Rate

We know that our 150 bu/ac corn crop requires 45 lb/ac P_2O_5.

We also know that our manure can supply 14.6 lb/ton of P_2O_5. Therefore, we can calculate a phosphorus-based manure application rate.

For this example:
The 150-bu/ac corn crop requires 45 lb/ac P_2O_5 *be supplied by manure.*
The manure can supply 14.6 lb of P_2O_5 *per ton.*
Therefore:
45 lb/ac x 1 ton/14.6 lb = 3 tons/acre

Step 15. Potassium-based Manure Application Rate

We know that our 150 bu/ac corn crop requires 185 lb/ac K_2O.

We also know that our manure can supply 38.5 lb/ton of K_2O. Therefore, we can calculate a potassium-based manure application rate.

For this example:
The 150 bu/ac corn crop requires 185 lb/ac K_2O be supplied by manure.
The manure can supply 38.5 lb of K_2O per ton.
Therefore:
185 lb/ac x 1 ton/38.5 lb = 5 tons/acre

Because of the significant differences between the nitrogen and phosphorous application rates, a phosphorous risk-assessment tool is needed to help determine the limiting nutrient. Please contact the State Conservation Agronomist for help in utilizing one of these risk assessment tools.

Step 16. Calculate Approximate Acres of Crop Needed

To calculate the approximate acres of crop needed, divide the total tons of manure produced (from step 3d) by the application rate for each respective nutrient.

For this example:

Nitrogen-based
Tons of manure = 2,253 tons
Application rate = 13 tons/acre
Acres needed = 2,253 tons x 1 acre/13 tons = 173 acres

Phosphorous-based
Tons of manure = 2,253 tons
Application rate = 3 tons/acre
Acres needed = 2,253 tons x 1 acre/3 tons = 751 acres

Potassium-based
Tons of manure = 2,253 tons
Application rate = 5 tons/acre
Acres needed = 2,253 tons x 1 acre/5 tons = 450 acres

Step 17. Spreader Calibration

To calibrate the spreader, we must know the spreader dimensions, as well as the density of the manure.

For this example:
Spreader is 20 feet long
Spreader is 6 feet wide
Spreader is 4 feet deep
Manure is 40 lb/ft^3 (density can be calculated by weighing 1 ft^3 of manure)

Volume of spreader = 20 x 6 x 4 = 480 ft^3

Using the density of the manure, convert to lbs per load

480 ft^3/load x 40 lb/ft^3 = 19,200 lb/load = 10 tons/load

Top calculate loads per acre, divide the application rate by the ton/load.

For this example (for nitrogen-based application rate only):
Nitrogen-based
14 tons/acre x 1 load/10 tons = 1.4 loads/acre

Step 18. Recommended Timing of Application

Record the planned method and timing of manure application in this block. The timing and method of nutrient application have a significant affect on the efficiency of nutrient use by plans. Avoid applying manure in the winter and on frozen or snow-covered ground.

Step 19. Operation and Maintenance

Waste Utilization Plans should be reviewed annually by the producer, and a more thorough review performed at least every 5 years. Any significant change to the operation warrants a review and/or modification to the plan.

Field records should be maintained for at least 5 years, though some producers may wish to retain records indefinitely.

Application equipment should be calibrated so that it will apply nutrients to within 10% of the expected rate. Uniform application across the field is vital. Generally, no more than 10 – 15% variance in the required application rate from the actual amount applied is allowed.

Step 20. Additional Specifications and Notes

Write any additional specifications and notes in the box provided. Additional notes may include any constraints not previously noted, special nutrient requirements of the crop, equipment constraints, constraints due to pest pressures, residue limitations, conservation buffer requirements, local regulations, and any other information of interest to the producer. Additional notes may also refer to sources of information used to calculate available nutrients and nutrient requirements.